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(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

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DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371**

Li-71 472

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/446320

INTERNATIONAL APPLICATION NO.

PCT/DE98/01656

INTERNATIONAL FILING DATE

6/11/1998

PRIORITY DATE CLAIMED

6/20/1997

**TITLE OF INVENTION**

Redundant Serial Bus and Method For the Operation Thereof

**APPLICANT(S) FOR DO/EO/US**

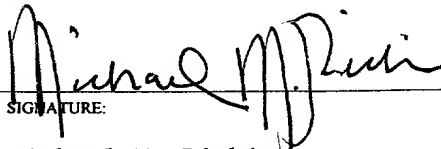
Jantzen, Wolfgang

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

**Items 11. to 16. below concern document(s) or information included:**

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A **FIRST** preliminary amendment.  
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

U.S. APPLICATION NO (if known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION NO		ATTORNEY'S DOCKET NUMBER	
09/446320		PCT/DE98/01656		Li-71 472	
17. <input checked="" type="checkbox"/> The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. .... \$970.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$840.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$760.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$670.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$96.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				CALCULATIONS      PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	11 - 20 =		X \$18.00	\$	
Independent claims	1 - 3 =		X \$78.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00	\$ 260	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$ 1100</b>	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$	
<b>SUBTOTAL =</b>				<b>\$</b>	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				<b>\$ 1100</b>	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
<b>TOTAL FEES ENCLOSED =</b>				<b>\$ 1100</b>	
				Amount to be: refunded	\$
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a. <input type="checkbox"/> A check in the amount of \$ _____ to cover the above fees is enclosed.					
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<b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>					
SEND ALL CORRESPONDENCE TO:			Michael M. Rickin ABB Automation Inc. Legal Department - 4U6 29801 Euclid Avenue Wickliffe, OH 44092		
04:14 PM 22 DEC 99 BRANCH DOCUMENT PROCESSING			 SIGNATURE:		
			Michael M. Rickin NAME		
			26,984 REGISTRATION NUMBER		

**Redundant serial bus and method for its operation**

5

**Description**

The invention relates to a redundant serial bus and to a method for its operation.

10 The general problem is to connect serial bus systems which are known per se but have no system-integrated redundancy means, that is to say correctly standardized and thus interoperable bus systems, to one another by means of bus lines of redundant design.

15 Furthermore, there is a problem in selecting one of the bus lines of redundant design for communication in that it is no longer possible to identify complex faults at the purely physical level by, for example, transmission level identification. The evaluation must be carried out at a higher level of protocol processing. First of all, at least a portion of the serial transmission must be identified as being correct  
20 before the selected line can be selected for receiving the message. The monitored portion of the message must be at least sufficiently long that reflections, which may have a specific delay time on the bus, are reliably identified.

25 Normally, bus systems use special bus controllers for the lower layers of the transmission protocol. If these controllers do not provide appropriate redundancy, the necessary locations for the implementation of appropriate redundancy are no longer accessible to a user of this controller.

30 It is known from the publication "Automatisierungstechnik" [Automation Engineering] R. Oldenbourg Verlag Vienna 1992, Volume I, page 406 for the data traffic to be switched from the active bus to a passive bus in a redundant system when a changeover criterion occurs, in which case the respective active bus represents a selection, which can be predetermined, of identical and equal-  
35 priority buses in the redundant bus system. Failures of the active bus and cyclic interrogations of the difference between the transfer requests on the active and passive buses are intended to be used as the changeover criterion.

A method for operation of an asynchronous and redundant serial bus, comprising  $n > 1$  parallel independent lines, is known from DE 195 13 318, in which at least two multiplexers are provided which can be synchronized to one another and are suitable for bidirectional transmission of data information between a serial bus interface and one of the parallel lines. In this case, the invention provides that a preferred line of the redundant serial bus is defined as the primary bus and the  $n-1$  remaining lines are defined as standby buses, that, when data traffic takes place without any disturbance, data information is interchanged between the stations connected via the multiplexers, via the primary bus as the active bus, and control information is interchanged between the multiplexers via at least one bus which can be predetermined, that, if the transmission quality on the active bus falls below a limit which can be predetermined, a standby bus which can be predetermined is defined as the active bus, a fault message is passed to a higher-level entity and the deactivated bus is analysed, and that, if the transmission quality of the primary bus rises beyond a limit which can be predetermined, the primary bus is defined as the active bus once again.

In this case, the complexity for synchronization of all the bus subscribers to the active bus is regarded as being disadvantageous both in terms of material and with respect to the protocol functions required for this purpose. Since the synchronization means are bus subscribers themselves, the number of available subscriber addresses for stations that can be connected is, furthermore, reduced.

An Ethernet bus system which can be segmented and has  $n > 1$  bus lines is known from DE 195 13 316 for redundant networking of single-port stations with one control output and one communications port, in which bidirectional multiplexers are provided, having one multiplexed port and  $n$  line ports, and a control input. At least one monitoring device having  $n$  line ports is connected to the  $n$  bus lines of an Ethernet segment. Each single-port station is assigned a multiplexer, in which case the communications port of the single-port station is connected to the multiplexed port of the multiplexer, and the control output of the single-port station is connected to the control input of the multiplexer. The  $n$  line ports of each multiplexer are connected to the  $n$  bus lines of an Ethernet segment.

Disadvantageously, each single-port station has to be equipped with a control output for controlling the multiplexer. Particularly when retrofitting redundant bus lines in existing systems, no such control output is available.

Furthermore, an Ethernet bus system, which can be segmented, is known from DE 195 13 315 for redundant networking of single-port stations, in which two lines are arranged in parallel, at least in segment elements, and addressable  
5 bidirectional multiplexers are provided as active network subscribers for connection of the single-port stations to the two lines, which multiplexers can be controlled by means of at least one monitoring unit, which can be addressed as an active network subscriber.

10 A disadvantage in this case is the large number of network addresses required, which limits the number of possible single-port stations in the same network.

The invention is based on the object of specifying means which allow serial bus systems which are known per se and have no system-integrated redundancy means to be connected to one another by means of bus lines of redundant  
15 design. In this case, the existing bus system is intended to remain as uninfluenced as possible, and to be capable of compatible use. Mixed operation with non-redundant subscribers is intended to be possible, and the redundancy means are intended to identify and process even relatively complex faults, such  
20 as incorrect bus terminations and the like, correctly.

According to the invention, this object is achieved by the means of Patent Claim 1 and the steps in Patent Claim 10. Advantageous refinements of the invention are described in the dependent Claims 2 to 9 and 11.

25 The invention now comprises, for each of the receiving lines, additionally handling a portion of the protocol in the upstream device in order to satisfy the necessary decision criteria. After the evaluation, a line which has been identified as being fault-free is then selected. The selected line is then converted back to  
30 the original signal, in such a way that it can be read to the normal communications controller or the appliance.

The invention is in this case based on the knowledge that faults in the transmission path can normally be identified in the preamble or, in the case of  
35 UART protocols, during the transmission of the first byte.

According to the invention, an upstream device is provided to which, on the one hand, bus lines of redundant design and, on the other hand, subscribers or appliances without system-integrated redundancy means are connected, in

which case one of the bus lines is in each case connected to the connected subscriber or appliance, completely dispensing with system-integrated redundancy means.

5 In such redundant bus systems, transmissions are always made on all the lines, while any fault-free line is selected for reception. This means that different receivers connected to the same bus lines can identify different bus lines as being fault-free.

10 The available bus controllers can still be used, in an advantageous manner. Furthermore, existing appliances with bus controllers but without system-integrated redundancy means can easily be networked redundantly, without changing the system architecture. There is no need for any additional subscriber addresses for synchronization means.

15 The concept of upstream redundancy applies to all types of serial communication, and is implemented in the physical layer. One receiving line from  $n$  ( $n \geq m+1$ ) receiving lines is selected for redundancy, depending on the validity of a data stream. The selection applies for the duration of a transmission block (frame). Transmission takes place on all the transmitting lines. Receiving and transmitting lines may be combined to form a bidirectional bus line.

20 The invention will be explained in more detail in the following text with reference to an exemplary embodiment with two parallel bus lines. In the drawings required for this purpose:

Figure 1 shows an outline illustration of a redundant bus system

Figure 2 shows a block diagram of a redundancy means which can be  
30 connected upstream

Figure 3 shows an outline illustration of a redundant bus system with monitoring

35 Figure 4 shows a block diagram of a redundancy means which can be connected upstream, with monitoring

The outline of a redundant bus system according to the invention is shown in Figure 1. Groups 21 to 25 of bus subscribers 2 are connected to a redundant

serial bus 1, which comprises two bus lines 11 and 12, with each of the bus subscribers 2 having a single, redundancy-free bus communications interface 200.

5 The bus subscribers 2 in the first and second groups 21 and 22 are each connected via a subscriber-specific redundancy means 3, which can be connected upstream, to both bus lines 11 and 12 of the redundant serial bus 1. The bus subscribers 2 in the fourth group 24 are connected via a redundancy-free serial bus 4 and a common redundancy means 3, which can be connected  
10 upstream, to both bus lines 11 and 12 of the redundant serial bus 1. The bus subscribers 2 in the third group 23 are connected exclusively to the bus line 11 of the redundant serial bus 1. The connection to one of the bus lines 11 and 12 is in this case advantageously optional, and the connections can be mixed. There is no need for any preferred position in this case.

15 The redundancy of the serial bus 1 can be scaled in a particularly advantageous manner to satisfy the requirements for availability of the individual bus subscribers 2. Furthermore, mixed operation of subscribers 2, connected in a redundant and non-redundant fashion, on the same redundant serial bus 1 is  
20 possible.

The fifth group 25 comprises so-called repeaters, which are each intended for connecting one bus line 11 and 12 in a first segment to in each case one bus line in a second segment of the same bus system.

25 Figure 2 shows the outline structure of a redundancy means 3 which can be connected upstream. The redundancy means 3 which can be connected upstream is equipped with a receiver 31 and a transmitter 32. The receiver 31 comprises in each case one input stage 311, one evaluation stage 312 and one  
30 output stage 313 at least for each bus line 11 and 12. The input stage 311 is equipped with means for synchronization, filtering and serial/parallel conversion. Furthermore, means may also be provided for evaluation of the data stream (parity, framing ...), and the states may be passed on to the evaluation stage 312. It is expedient for the input stage 311 to have an amplifier 314 connected  
35 upstream of it, which has means for matching the input stage 311 to the physical transmission medium of the bus line 11 and 12 of the redundant serial bus 1.

The evaluation stage 312 comprises means for evaluation of the data stream, for time evaluation, for assessing the state of the receiving lines and for line selection.

- 5 The output stage 313 has means for parallel/serial conversion, for muting in the case of faulty received data and driver stages (RS485, RS232, optical conductor, ...) for matching to the redundancy-free bus communications interface 200 of the bus subscribers 2. Alternatively, it is possible for the serial data stream, delayed for the reception identification time, to be passed on directly  
10 from the input stage 311 to the output stage 313. There is then no need for the parallel/serial conversion.

In the input stage 311, the received signal is passed via a filter to a synchronization stage. In the synchronization stage, the receiver 31 is  
15 synchronized to the data stream. The transmission rate can be configured or identified automatically. The incoming data stream is evaluated for automatic rate identification. The data stream may be passed on to the evaluation stage 312 in serial or parallel form.

- 20 In the evaluation stage 312, the receiving line 11 or 12 is selected on the basis of criteria which are determined from the serial or parallel data stream, the time response and the state of the receiving line 11 and 12. The criteria from the data stream include the frame error, parity error, preambles, synchronization sequences, etc. Further criteria are derived from the time response, from pause  
25 times during the data transfer or from the data transfer duration. A time-dependent changeover strategy may also provide criteria. One selection criterion which may characterize the state of the receiving line 11 and 12 is also the signal level, which indicates an overload or underload.

- 30 In the output stage 313, bit retiming is carried out for the data stream which has been identified as being valid and has been selected, and this is output via a driver stage. The time delay which occurs in the redundancy means 3 which can be connected upstream is not critical since it is in the same order of magnitude as the cable propagation times (reflection propagation time). If no valid data  
35 stream is identified, then the output stage 313 supplies the rest state as the output signal.

At the transmitting end, the redundancy means 3 which can be connected upstream has a transmitter 32 with in each case one driver 321 for each bus line



11 and 12 of the redundant serial bus 1. The data stream to be transmitted is output via the drivers 321 to all the bus lines 11 and 12.

5 Using the same reference symbols for the same means, Figure 3 shows the outline of a redundant bus system in which selected bus subscribers 2 are equipped with diagnosis means. In this case, the selected bus subscribers 2 in the first subscriber group 21 are equipped with an additional diagnosis interface 201 and are connected by means of additional control lines 5 to the associated redundancy means 3 which can be connected upstream.

10 In this context, Figure 4 shows a block diagram of a redundancy means 3 which can be connected upstream, with additional control lines 5 for monitoring and diagnosis. The evaluation stage 312 in the receiver 31 has an output for outputting status information, and inputs for selection of a dedicated bus line 11 or 12 as the receiving line, which is connected via in each case one of the additional control lines 5 to the additional diagnosis interface 201 of the selected bus subscriber 2 in the first subscriber group 21.

20 Furthermore, the receiver 31 has means for testing and for diagnosis, which allow the receiver 31 to be set to different operating modes. In addition to selecting a bus line 11 or 12 as the receiving line, which is called the normal mode, reception on a permanently set bus line 11 or 12 is also envisaged, as a function of the validity of a data stream, in which case the evaluation stage 312 may be switched on and off.

25 For test and diagnosis purposes, the receiver 31 can be configured such that reception takes place exclusively on a specific bus line 11 or 12. In this case, it is possible for the selected bus line 11 or 12 to make a direct connection between the input and the output of the receiver 31. For this purpose, the evaluation stage 312 of the receiver 31 is initialized appropriately by the selected bus subscriber 2, via the control lines 5.

35 At the transmitting end, the invention provides, for test and diagnosis purposes, for the data stream to be output in a specifically configurable manner on exclusively one or more bus lines 11 and 12. For this purpose, the drivers 321 in the transmitter 32 are equipped with gate circuits, by means of which the output of the respective driver 321 is muted. Each gate circuit has a control input, which is connected via one of the control lines 5 to the diagnosis interface 201 of the selected subscriber 2.

During diagnosis, a selected subscriber may deliberately transmit and receive data via one and the same selected bus line 11 or 12. This method identifies a defective bus line 11 and 12, and signals this to a higher-level device.

Patent Claims

1. Redundant serial bus having  $n > 1$  parallel bus lines for redundant networking of bus subscribers each having a single bus communications interface,  
5 characterized
- in that a redundancy means (3), which can be connected upstream, having  $n$  interfaces for connection to  $n$  parallel bus lines (11, 12) and one interface for connection to the single bus communications interface (200) of at least one bus subscriber (2) are provided,  
10
  - in that the redundancy means (3) which can be connected upstream has, at the receiving end, an input stage (311) at least for each bus line (11, 12), and has an evaluation stage (312) and an output stage (313) for all the bus lines (11, 12),  
15
  - in that the evaluation stage (312) has means for evaluating the validity of a data stream and for selection of one of the bus lines (11, 12) as the receiving line, and
  - in that the redundancy means (3) which can be connected upstream has, at the transmitting end, a driver (321) for each bus line (11, 12).  
20
2. Redundant serial bus according to Claim 1, characterized  
in that the input stage (311) has means for synchronization and filtering.
- 25 3. Redundant serial bus according to one of Claims 1 and 2, characterized  
in that the input stage (311) has means for serial/parallel conversion.
- 30 4. Redundant serial bus according to Claim 3, characterized  
in that the output stage (313) has means for parallel/serial conversion.
5. Redundant serial bus according to Claim 1, characterized  
35 in that the evaluation stage (312) has means for evaluation of the data stream, for time evaluation, for assessment of the state of the receiving lines and for line selection.
6. Redundant serial bus according to one of Claims 1 to 5,

characterized

in that the redundancy means (3) which can be connected upstream can be permanently set to one bus line (11, 12) on the receiving side.

- 5 7. Redundant serial bus according to one of Claims 1 to 5,  
characterized

in that the redundancy means (3) which can be connected upstream can be permanently set to one bus line (11, 12) on the transmitting side.

- 10 8. Redundant serial bus according to Claim 7,  
characterized

in that each driver (321) comprises a gate circuit for muting the driver output.

- 15 9. Redundant serial bus according to one of Claims 1 to 8,  
characterized

- in that at least one selected bus subscriber (2) is equipped with a diagnosis interface (201) for connection of control lines (5),
- in that the evaluation stage (312) of the redundancy means (3) which  
20 can be connected upstream is equipped with connections for connection of control lines (5), and
- in that the gate circuits of the drivers (321) have control inputs which are connected by means of control lines (5) to the diagnosis interface (201).

- 25 10. Method for operating a redundant serial bus according to Claim 1,  
characterized

- in that, during operation, identical message packets are sent in parallel and at the same time to all the bus lines (11, 12),
- 30 - in that the identical message packets on all the bus lines (11, 12) are received in parallel by the redundancy means (3) which can be connected upstream,
- in that the data streams of the received message packets are checked for their validity, and
- 35 - in that, depending on the validity of the data streams, one of the bus lines (11, 12) is selected, whose data stream is passed on to the connected bus subscriber (2).

11. Method according to Claim 10,

characterized

in that data packets are sent and received on one and the same bus line (11, 12) in order to diagnose the redundant serial bus (1) with the same selected bus subscriber (2).

## Abstract

The invention relates to a redundant serial bus and a method for its operation. In order to connect serial bus systems which are known per se but have no system-integrated redundancy means to one another by means of bus lines (11, 12) of redundant design, a redundancy means (3) is proposed which can be connected upstream and is connected between the bus communications interface (200) of a bus subscriber (2) and the redundant bus lines (11, 12). In this case, during operation, transmission always takes place on all the bus lines (11, 12), and a fault-free bus line (11, 12) is selected at the receiving end.

Related figure, Figure 1

## List of reference symbols

- |           |  |
|-----------|--|
| 1         | Redundant serial bus                             |
| 11, 12    | Bus lines  |
| 2         | Bus subscribers                                  |
| 21 ... 25 | Subscriber groups                                |
| 200       | Bus communications interface                     |
| 201       | Diagnosis interface                              |
| 3         | Redundancy means which can be connected upstream |
| 31        | Receiver   |
| 311       | Input stage                                      |
| 312       | Evaluation stage                                 |
| 313       | Output stage                                     |
| 314       | Amplifier  |
| 32        | Transmitter                                      |
| 321       | Driver   |
| 4         | Redundancy-free serial bus                       |
| 5         | Control lines                                    |

the number of available subscriber addresses for stations that can be connected is, furthermore, reduced.

5

10 An Ethernet bus system which can be segmented and has  $n > 1$  bus lines is known from DE 195 13 316 for redundant networking of single-port stations with one control output and one communications port, in which bidirectional multiplexers are provided, having one multiplexed port and  $n$  line ports, and a control input. At least one monitoring device having  $n$  line ports is connected to the  $n$  bus lines of an Ethernet segment. Each single-port station is assigned a multiplexer, in which case the communications port of the single-port station is connected to the multiplexed port of the multiplexer, and the control output of the single-port station is connected to the control input of the multiplexer. The  $n$  line ports of each multiplexer are connected to the  $n$  bus lines of an Ethernet segment.

20 Disadvantageously, each single-port station has to be equipped with a control output for controlling the multiplexer. Particularly when retrofitting redundant bus lines in existing systems, no such control output is available.

25 Furthermore, an Ethernet bus system, which can be segmented, is known from DE 195 13 315 for redundant networking of single-port stations, in which two lines are arranged in parallel, at least in segment elements, and addressable bidirectional multiplexers are provided as active network subscribers for connection of the single-port stations to the two lines, which multiplexers can be controlled by means of at least one monitoring unit, which can be addressed as an active network subscriber.



A disadvantage in this case is the large number of network addresses required, which limits the number of possible single-port stations in the same network.

5 The invention is based on the object of specifying means which allow bus subscribers of a serial bus system which is known per se and has no system-integrated redundancy means to be connected to one another by means of bus lines of redundant design. In this case, the existing bus system is intended to remain as uninfluenced as possible, and to be capable of compatible use. Mixed  
10 operation with non-redundant subscribers is intended to be possible, and the redundancy means are intended to identify and process even relatively complex faults, such as incorrect bus terminations and the like, correctly.

According to the invention, this object is achieved by the means of Patent Claim  
15 1. Advantageous refinements of the invention are described in the dependent Claims 2 to 9.

The invention now comprises, for each of the receiving lines, additionally  
20 handling a portion of the protocol in the upstream device in order to satisfy the necessary decision criteria. After the evaluation, a line which has been identified as being fault-free is then selected. The selected line is then converted back to the original signal, in such a way that it can be read to the normal communications controller or the appliance.

25 The invention is in this case based on the knowledge that faults in the transmission path can normally be identified in the preamble or, in the case of UART protocols, during the transmission of the first byte.

30 According to the invention, an upstream device is provided to which, on the one hand, bus lines of redundant design and, on the other hand, subscribers or appliances without system-integrated redundancy means are connected, in which case one of the bus lines is in each case connected to the connected subscriber or appliance, completely dispensing with system-integrated redundancy means.

35 In such redundant bus systems, transmissions are always made on all the lines, while any fault-free line is selected for reception. This means that different receivers connected to the same bus lines can identify different bus lines as being fault-free.

- 5 The available bus controllers can still be used, in an advantageous manner. Furthermore, existing appliances with bus controllers but without system-integrated redundancy means can easily be networked redundantly, without changing the system architecture.

Patent Claims

1. Redundant serial bus system having  $n > 1$  parallel bus lines for redundant networking of bus subscribers each having a single bus communications interface, which is suitable for connection of a single bus line of the serial bus system,  
5 characterized
- 10 - in that a redundancy means (3), which can be connected upstream, having  $n$  bus communications interfaces for connection to  $n$  parallel bus lines (11, 12) and one bus communications interface for connection to the single bus communications interface (200) on at least one bus subscriber (2) are provided,
  - 15 - in that the redundancy means (3) which can be connected upstream has, at the receiving end, an input stage (311) at least for each bus line (11, 12), and has a common evaluation stage (312) and an output stage (313) for all the bus lines (11, 12),
  - 20 - in that the evaluation stage (312) has means for evaluating the validity of a data stream and for selection of one of the bus lines (11, 12) as the receiving line so that the output signal from the output stage (313) matches one of the signals on the bus lines (11, 12), and
  - in that the redundancy means (3) which can be connected upstream has, at the transmitting end, a driver (321) for each bus line (11, 12).

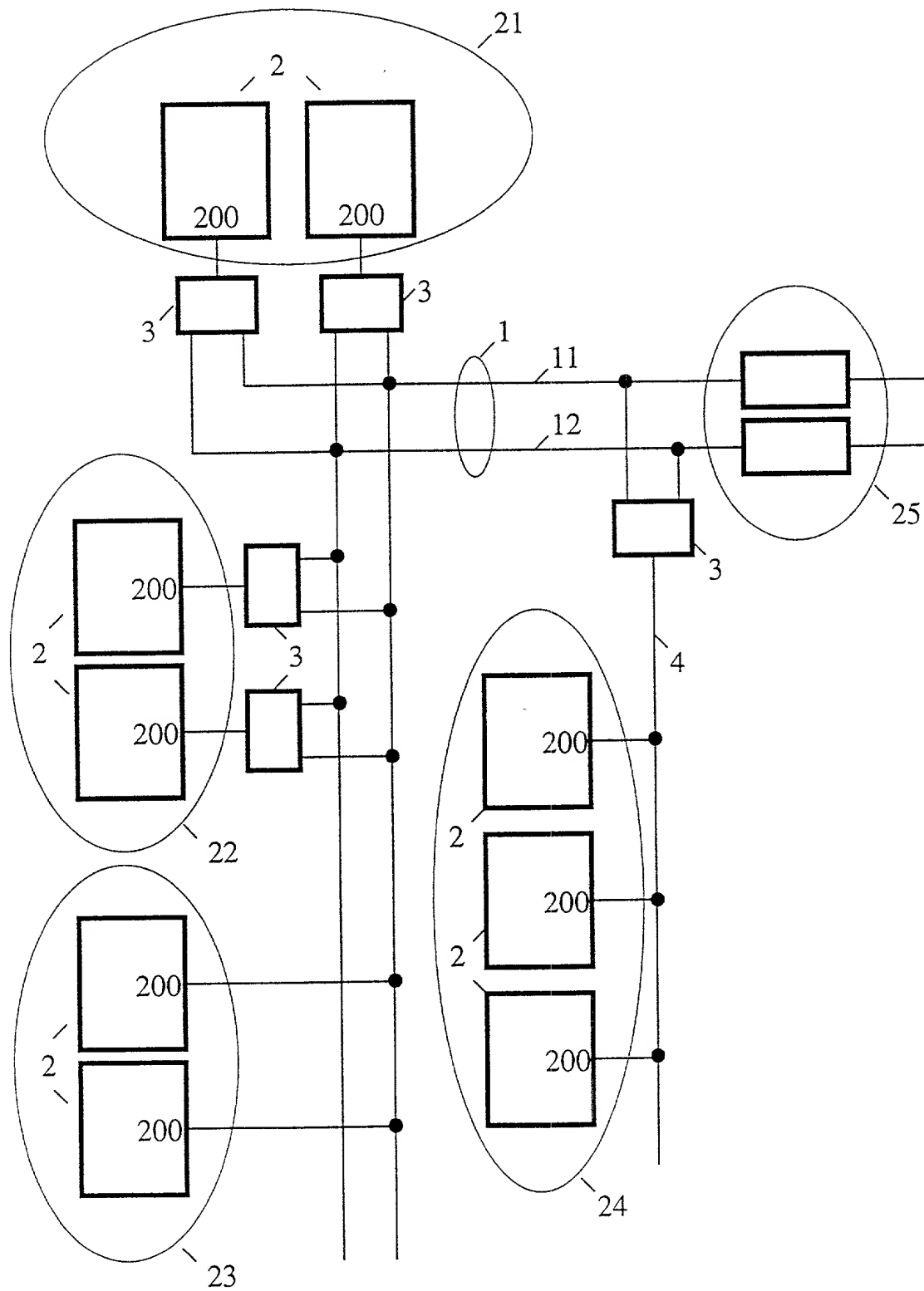


Fig.1

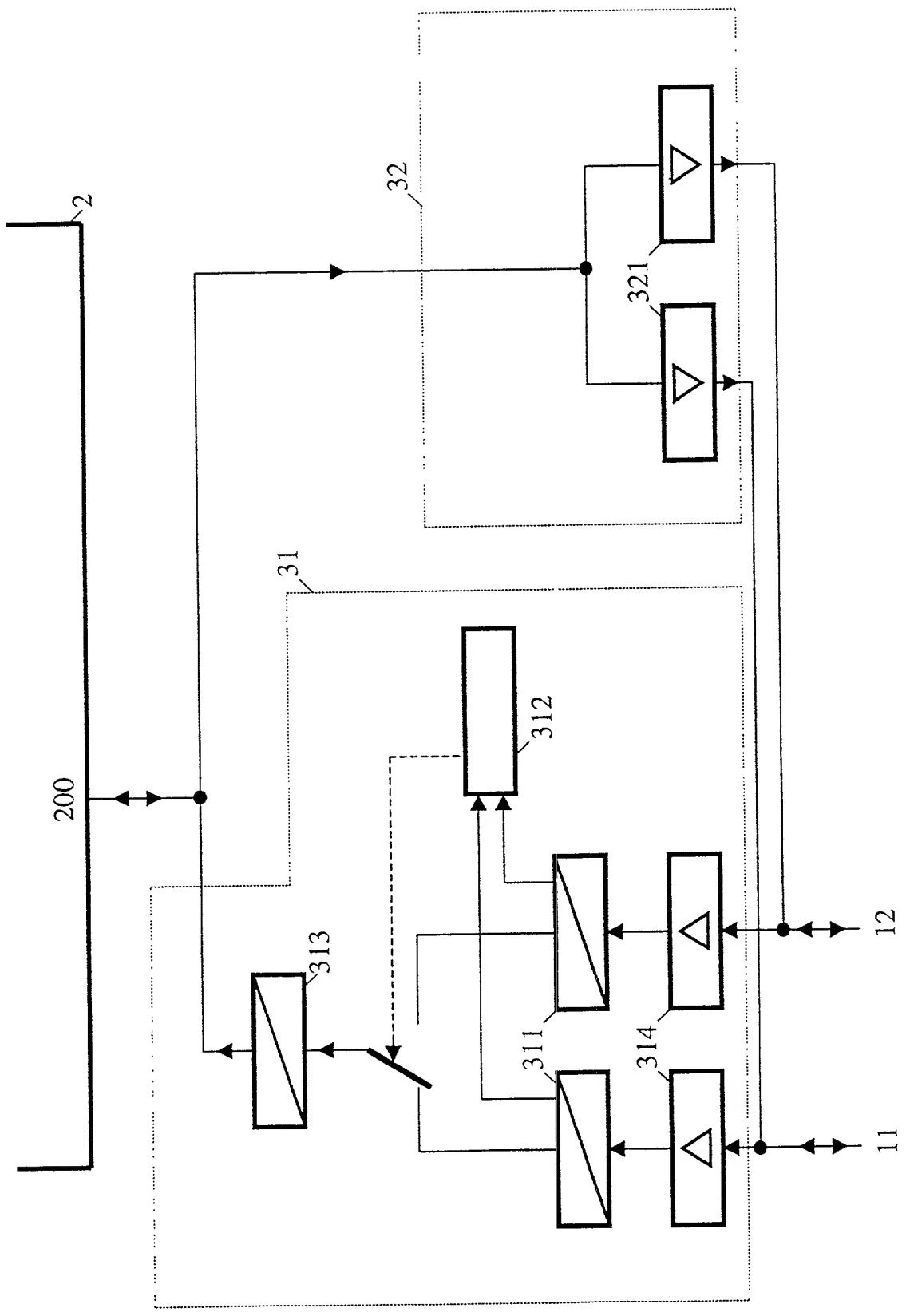


Fig.2

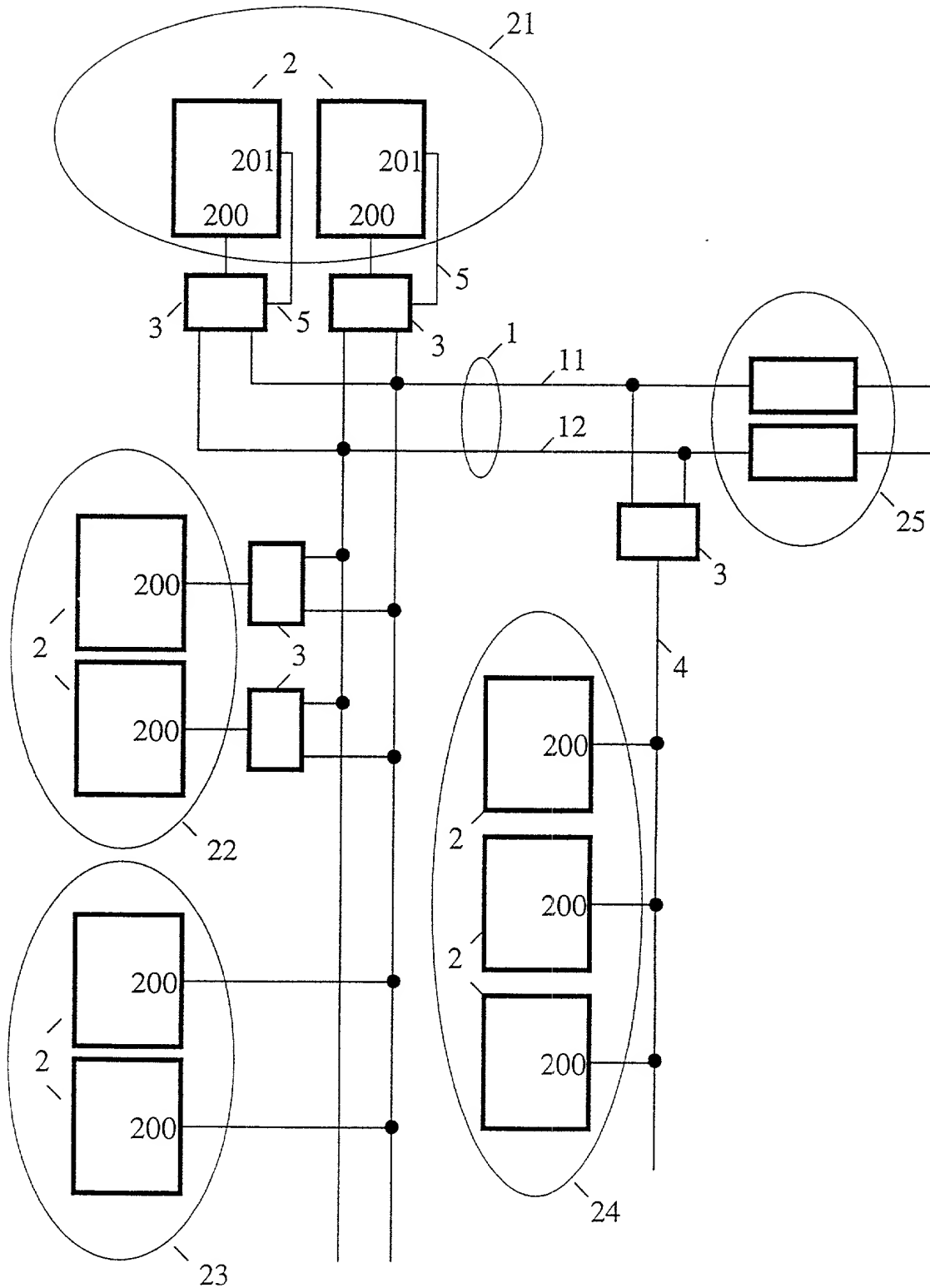


Fig.3

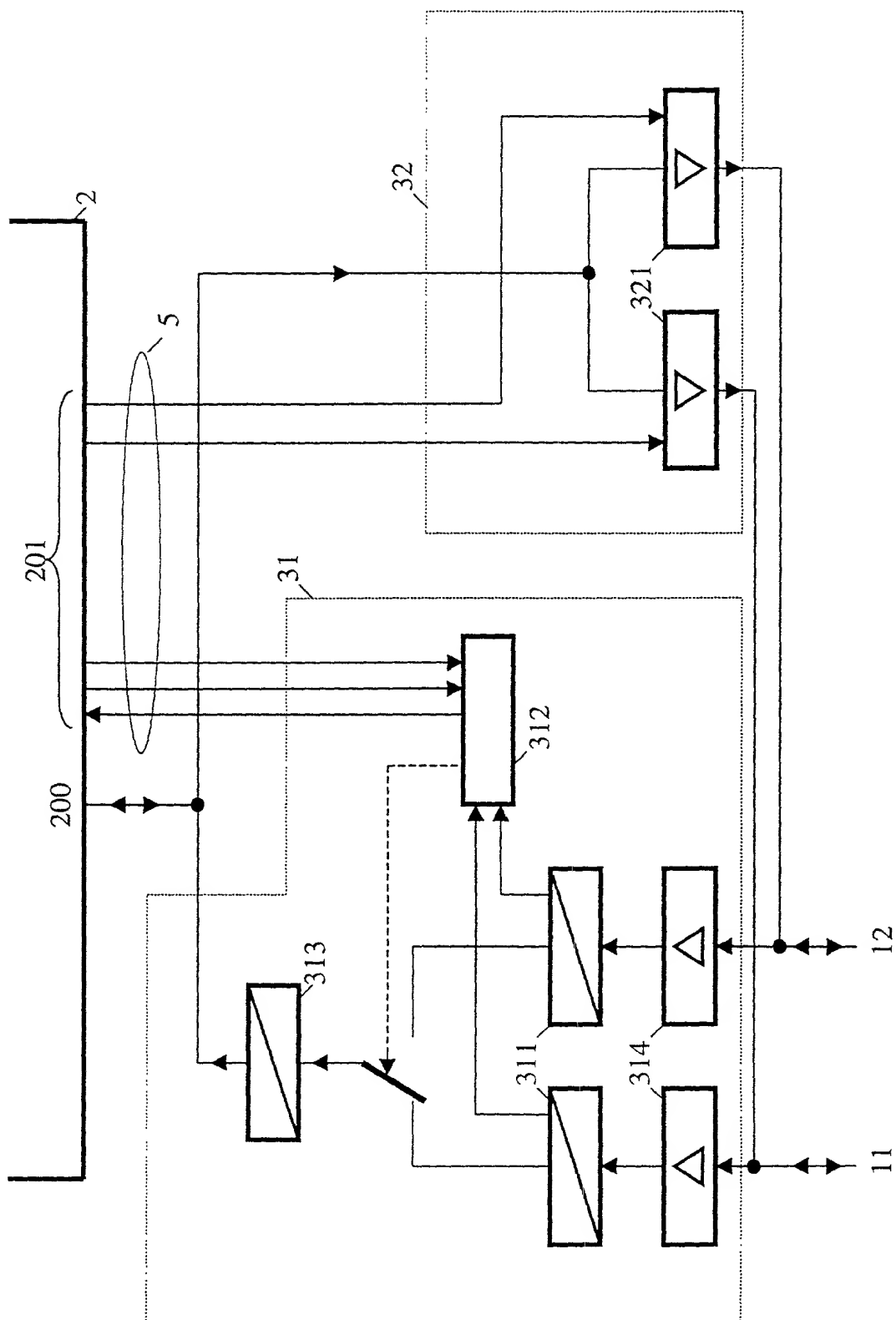


Fig.4

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# DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	Li-71 472
First Named Inventor	JANTZEN, Wolfgang
<b>COMPLETE IF KNOWN</b>	
Application Number	09 / 446,320
Filing Date	12/17/1999
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Redundant Serial Bus and Method For the Operation Thereof

the specification of which (Title of the Invention)

☐ is attached hereto  
OR

☒ was filed on (MM/DD/YYYY) 6/11/1998 as United States Application Number or PCT International

Application Number PCT/DE98/01656 and was amended on (MM/DD/YYYY) 11/25/1999 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
197 26 158.2	Germany	06/20/1997	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

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**DECLARATION — Utility or Design Patent Application**

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Customer Number 

OR

☒ Registered practitioner(s) name/registration number listed below

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Number Bar Code  
Label here

Name	Registration Number	Name	Registration Number
Michael M. Rickin	26,984		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number  OR ☒ Correspondence address below

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Country	U.S.A.	Telephone	(440) 585-7840	Fax	(440) 585-7578

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle [if any])		Family Name or Surname	
Wolfgang		Jantzen	
Inventor's Signature	Wolfgang Jantzen		Date
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Post Office Address	DE		
City	Minden	State	Country
ZIP	32425	Country	Germany

☐ Additional inventors are being named on the \_\_\_\_\_ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto